



ESO Programme status and update

Xavier Barcons
ESO



What is ESO

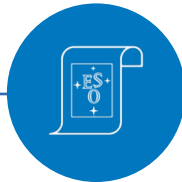
Intergovernmental Treaty Organisation

- + Founded in 1962
- + Headquarters in Germany
operating telescopes in Chile



ESO's Mission

- + Build and operate world-class
ground-based astronomical
facilities
- + Foster collaboration in
Astronomy



ESO employs over 750 staff

450 in Germany, 300 in Chile
from over 30 countries
52 employees from Spain



16 European Member States

Spain joined in 2006
strategic partner Australia
host and partner Chile



ESO's sites

Garching bei München (Germany)



Santiago (Chile)



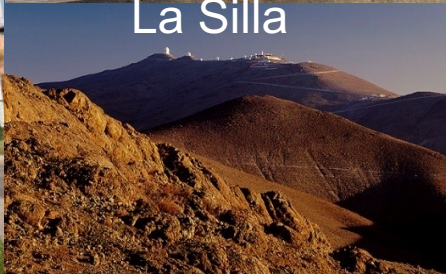
Chajnantor



Paranal



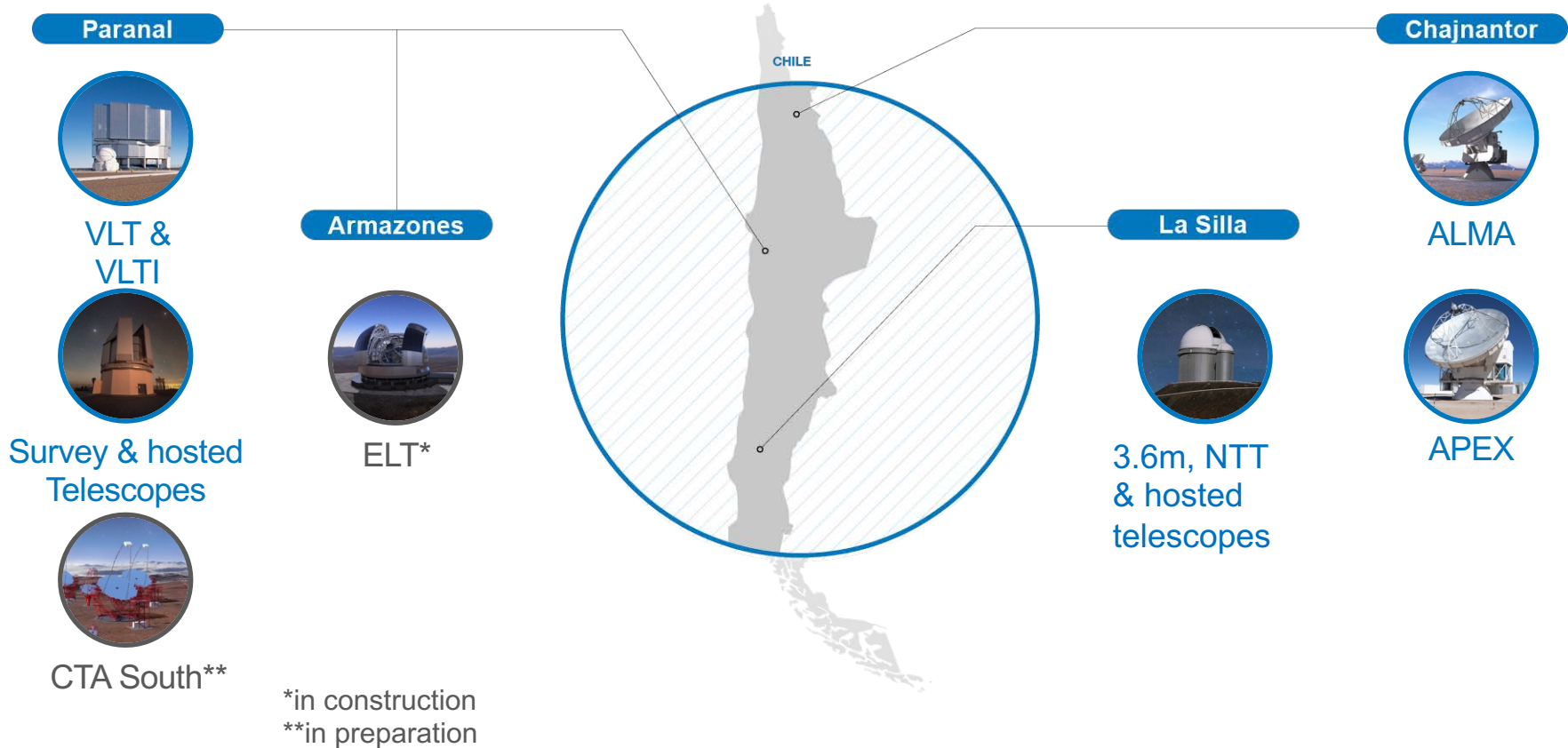
Armazones



La Silla



ESO telescopes



La Silla



and many hosted telescope projects...



TBT (ESA)



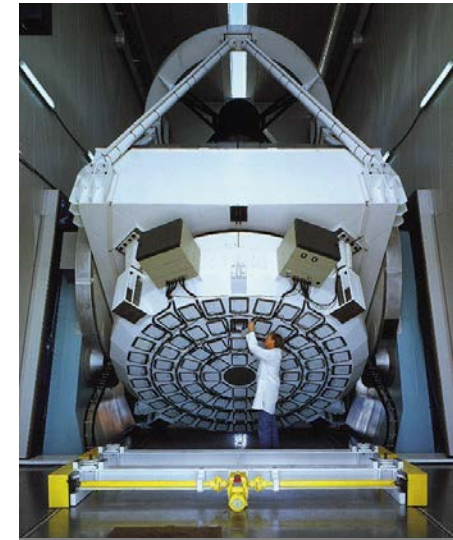
Black GEM



ExtraS

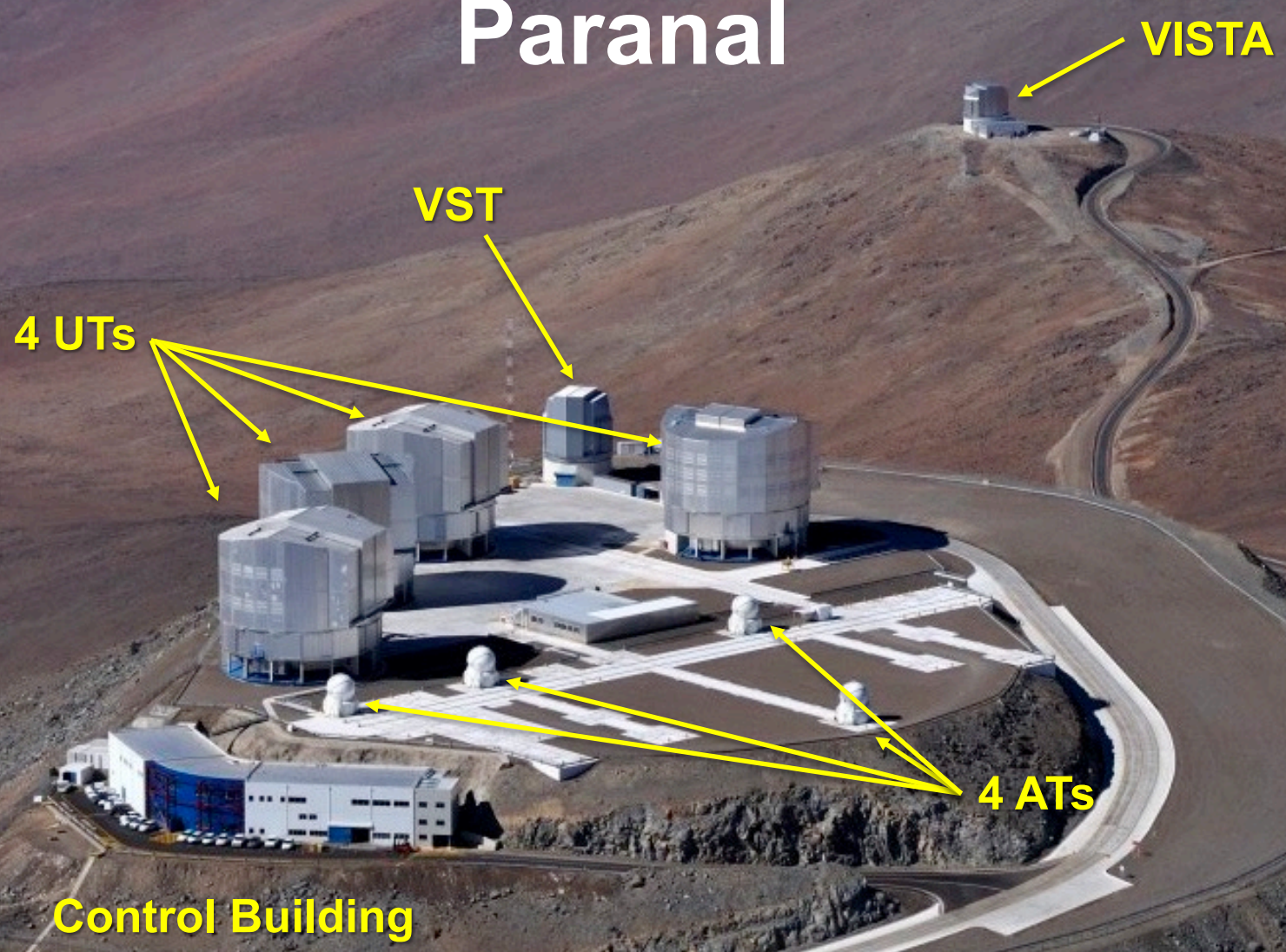


ESO 3.6 Metre

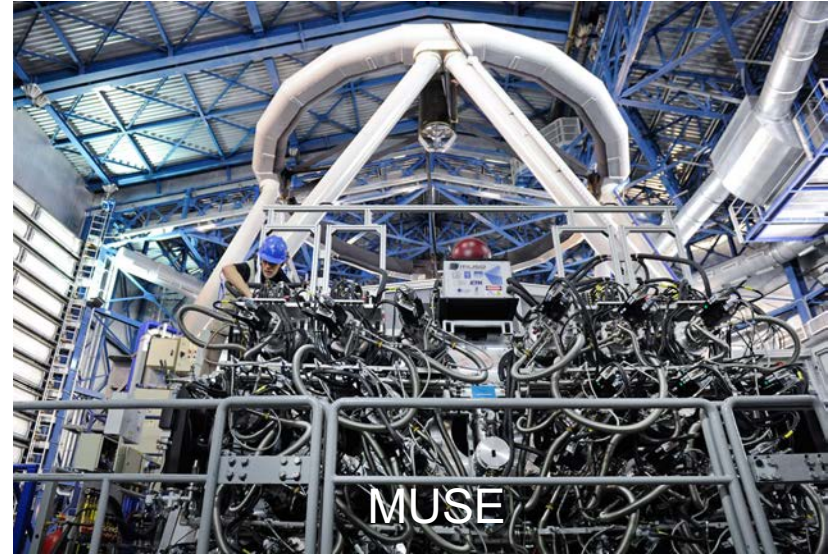


New Technology Telescope – 3.5 Metre

Paranal

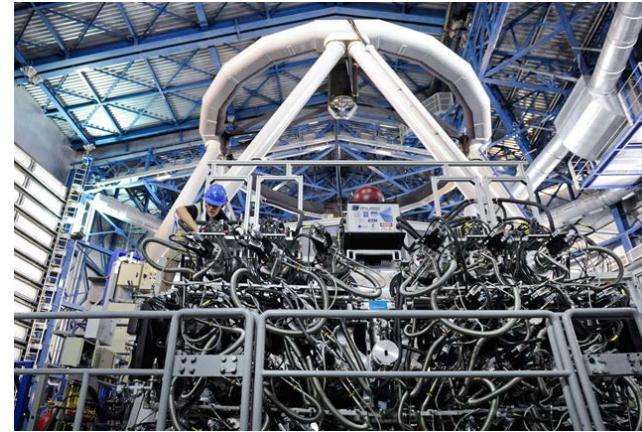


Very Large Telescope (VLT) and VLT Interferometer (VLTI)



The “Paranal model”

- ESO builds the telescopes and all the infrastructure
- Instruments are developed in partnership with consortia of R&D institutes and Universities
 - ESO provides capital costs and oversight
 - Effort from consortia (funded nationally) compensated by GTO
- ESO operates the entire facility
 - Technical downtime < 3%

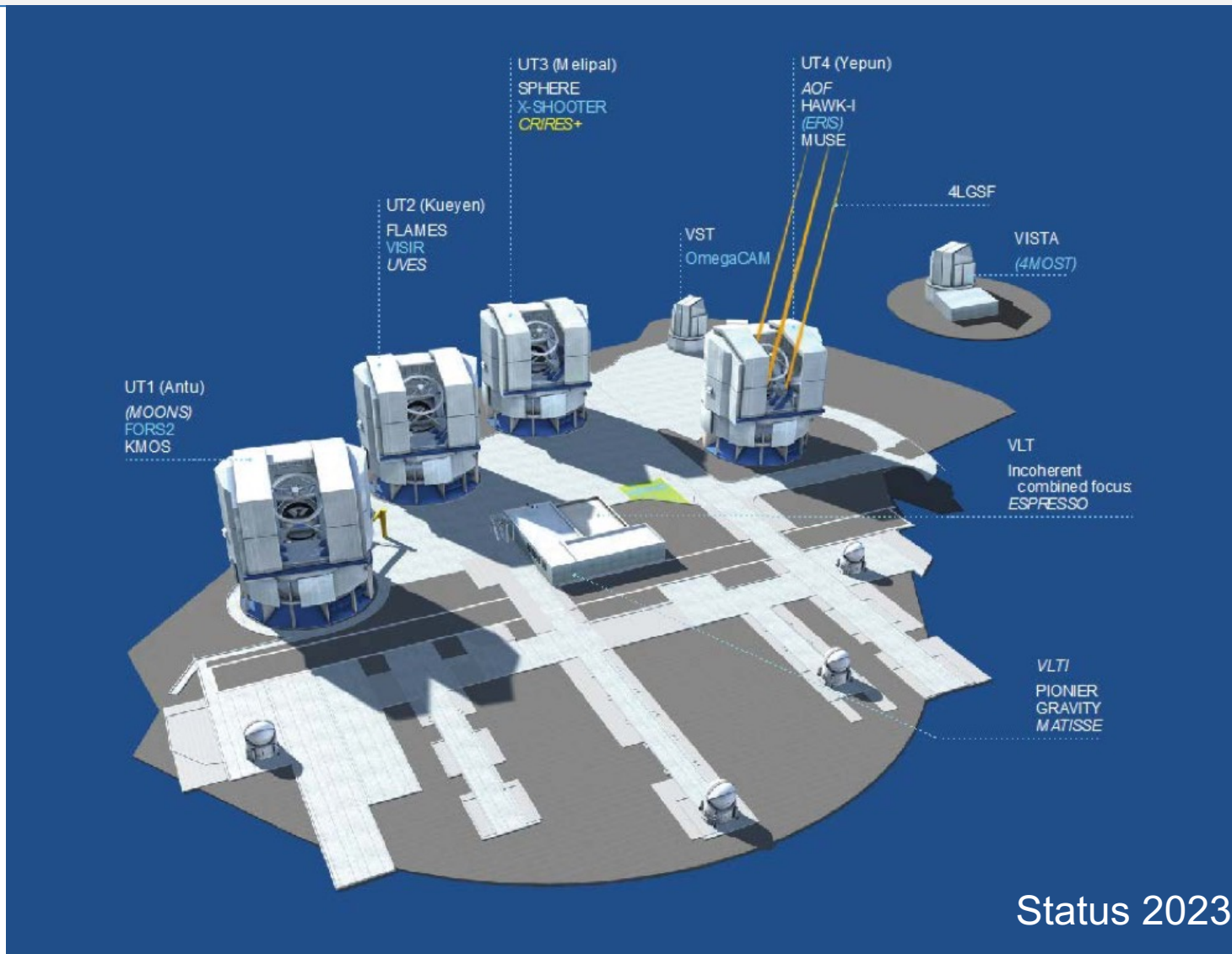


Paranal Instrumentation Programme

- Programme with a flat budgetary envelope to upgrade the instruments in VLT/I and La Silla
 - Approximately a new instrument every 2 years and an upgrade of an existing instrument every 2 years
 - In collaboration with community consortia
 - Instrument projects take 8-10 years (after Phase A)

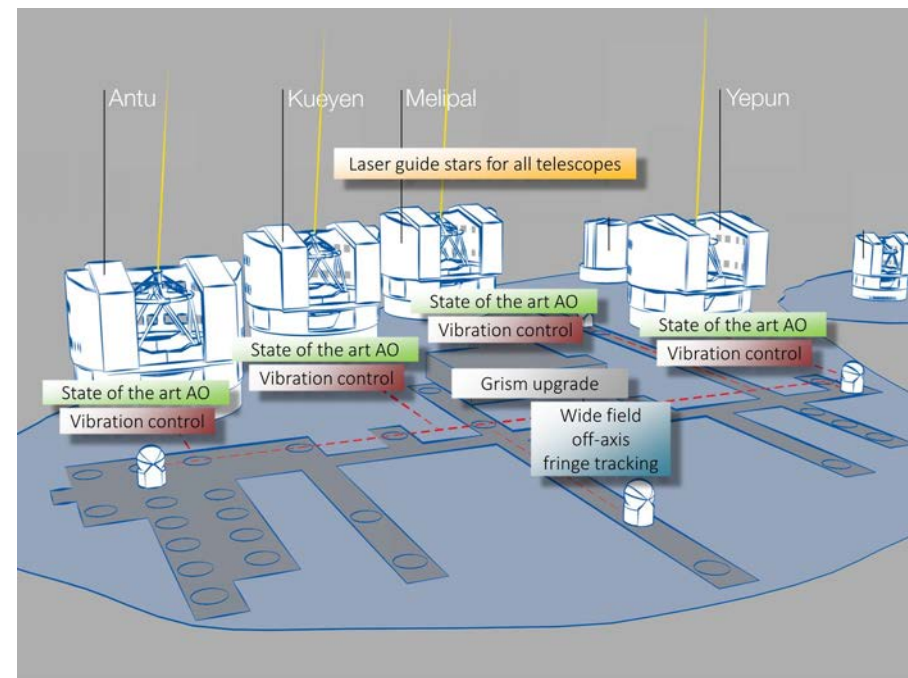
- Currently under development:
 - In installation/commissioning: ERIS (VLT), NIRP (3.6m in La Silla),
 - Next: SoXS (3.5m NTT in La Silla), 4MOST (VISTA), MOONS (VLT), CUBES (VLT) and MAVIS (VLT), GRAVITY+ (VLTI)
 - Upgrades: FORS+ (VLT)

VLT/I system



VLT/I in 2030: top priorities

- GRAVITY+: Go much fainter than GRAVITY and with full sky capability
 - VLT/I will remain unique post 2030
- Blue MUSE (Multi-object Spectrograph, large FoV)
- SPHERE+
 - Towards extreme adaptive optics



- Largest sub/mm radio interferometer
 - In operations since 2011
- Global partnership: ESO, NSF (USA) and NINS (JP)
 - In cooperation with the Republic of Chile
- Array Operations Site in Chajnantor (5050m)
 - 66 (movable) antennas, over a 16 km plateau
 - Back end and correlator
- Operations Support Facility at 3000m, near San Pedro de Atacama



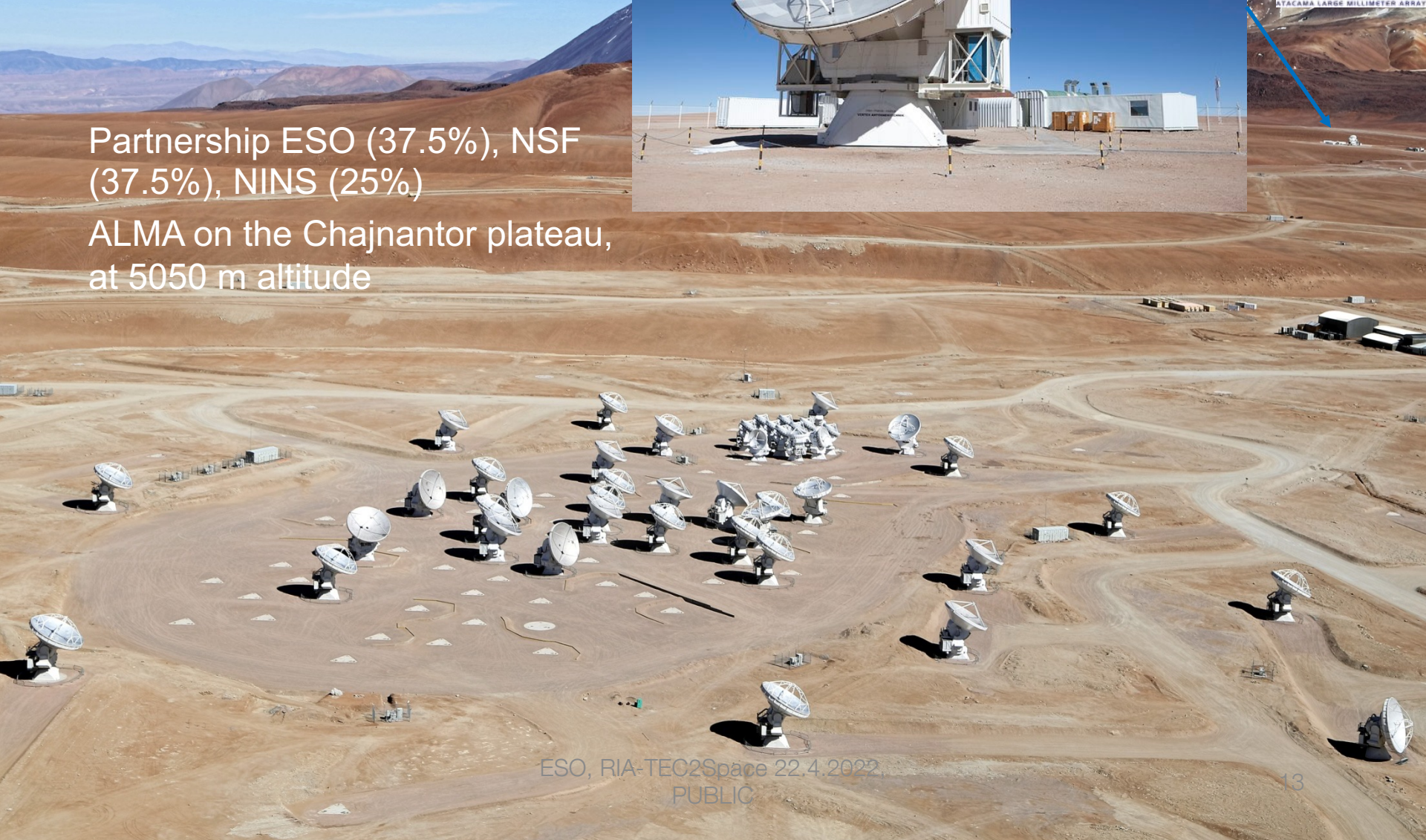


APEX



Partnership ESO (37.5%), NSF (37.5%), NINS (25%)

ALMA on the Chajnantor plateau, at 5050 m altitude





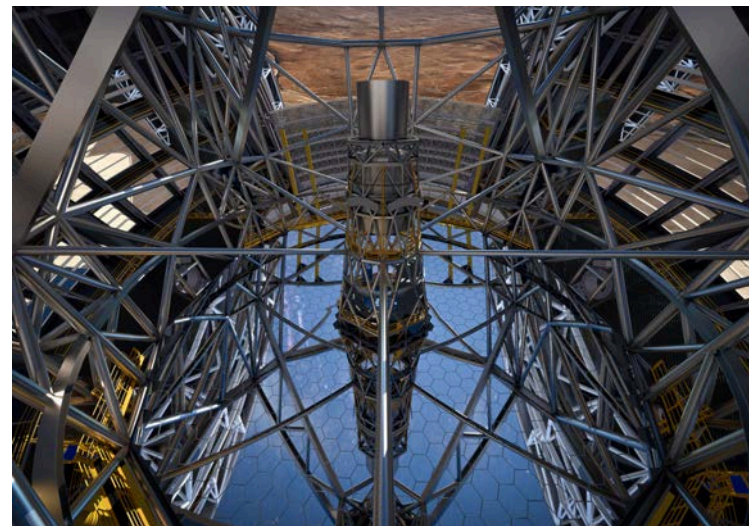
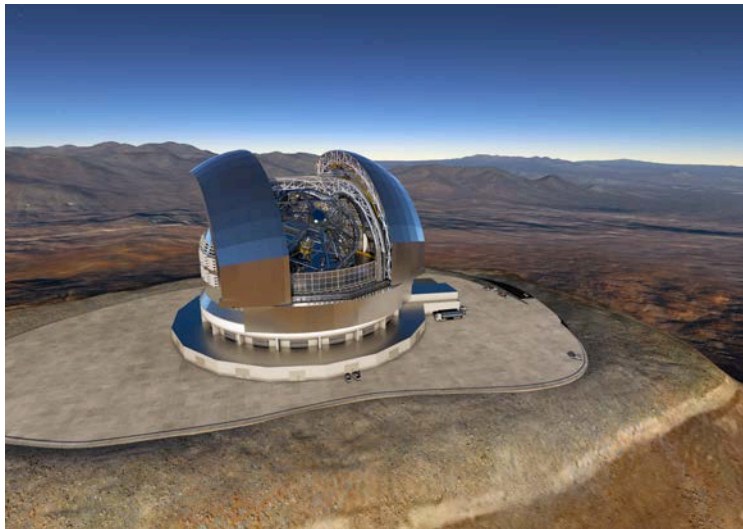
ALMA 2030

- ALMA Development funded through a budget line agreed across entire ALMA Partnership
 - Additional contributions ESO projects for the ALMA Development plan can be rewarded with GTO in ALMA
- **Top priority: Wideband Sensitivity Upgrade (WSU)** - broadening the receiver IF bandwidth at least by a factor of 2 (4), upgrading the associated electronics and correlator.
- Very challenging programme, costs and risks being assessed.

Extremely Large Telescope (ELT)

- Largest optical/infrared telescope in the world
 - 39.3 m segmented primary mirror & adaptive optics
 - Construction 2015-2027 (~1300 MEUR)
 - **First science observations in Sep 2027**
 - On Cerro Armazones, to be operated as part of the Paranal observatory

<https://elt.eso.org>



ELT construction site (Armazonos)



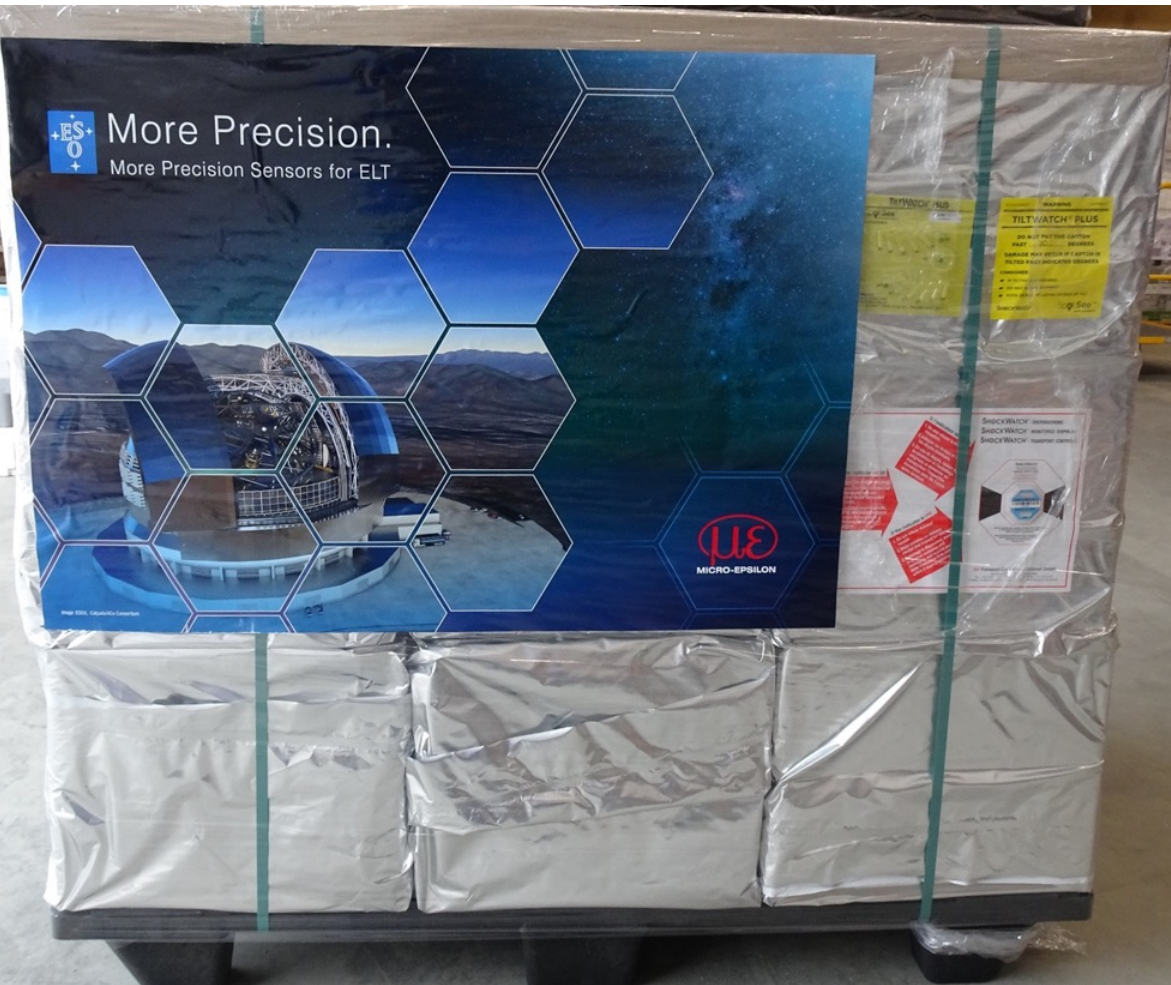
Cerro Armazonos (3050m)

ELT Technical Facility (Paranal)

M1 coater installation and commissioning



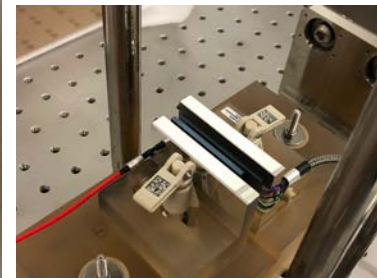
ELT manufacturing



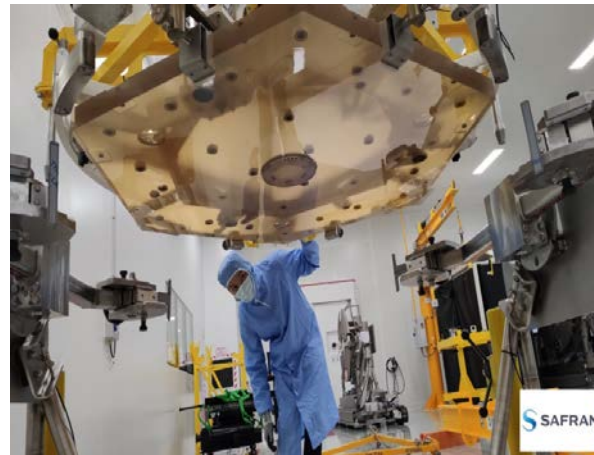
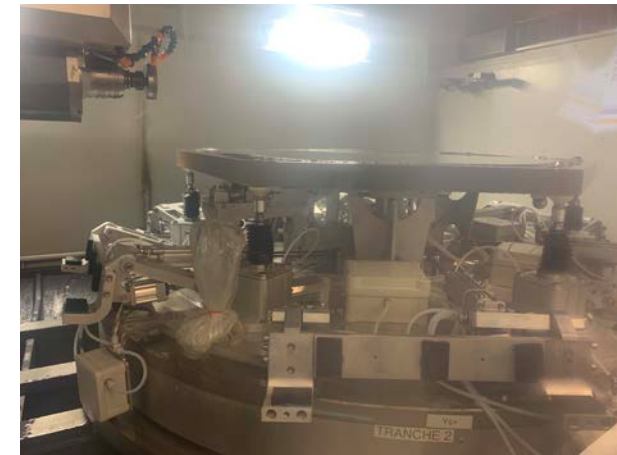
M1 edge sensors



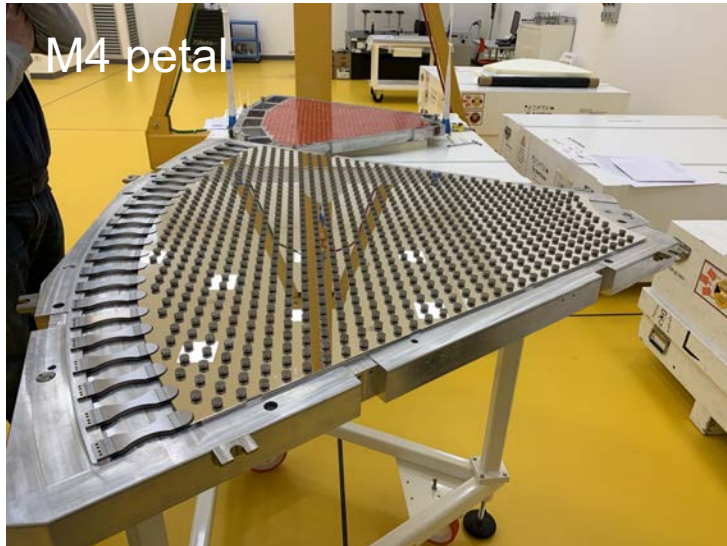
M1 position actuators



ELT Optomechanics



ELT optomechanics



M4 petal

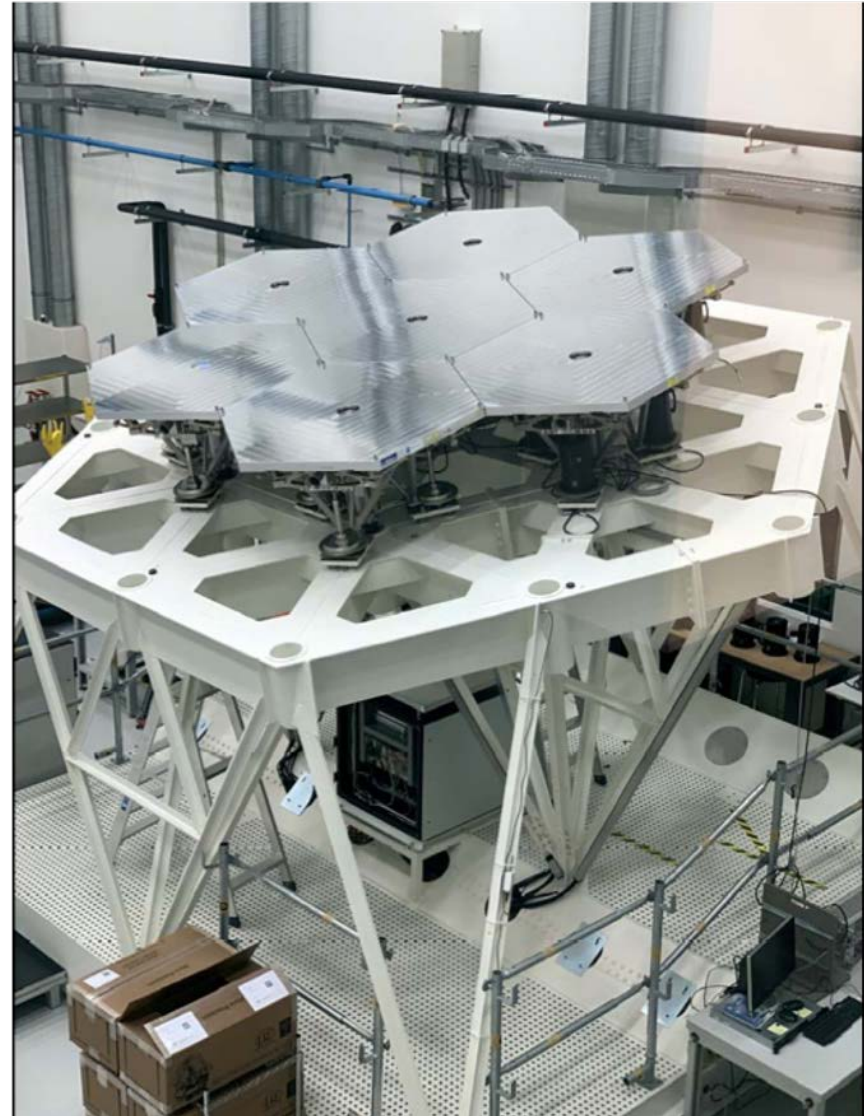


M4 shells delivered

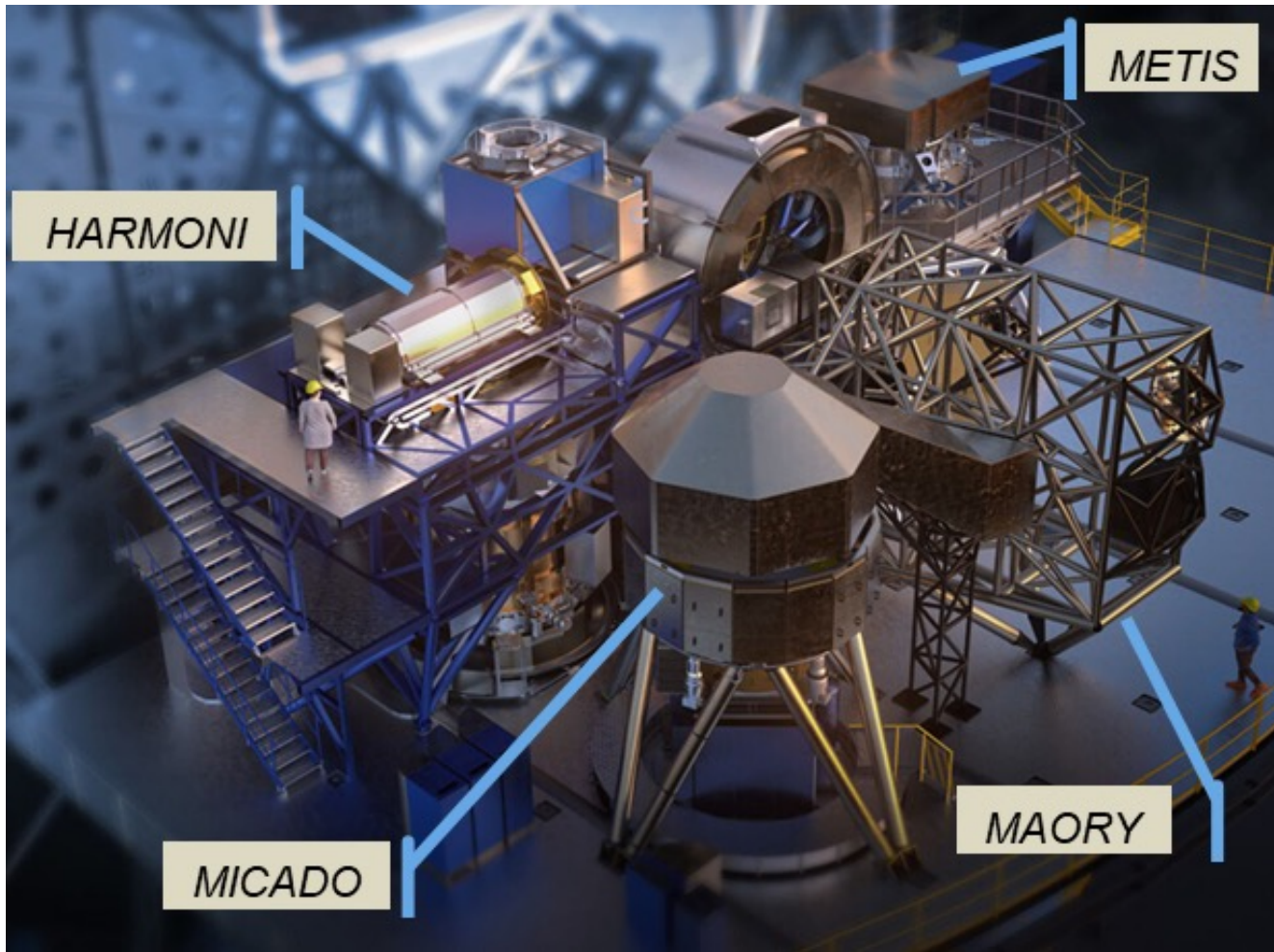


M2/3 cell

ELT in-house test activities



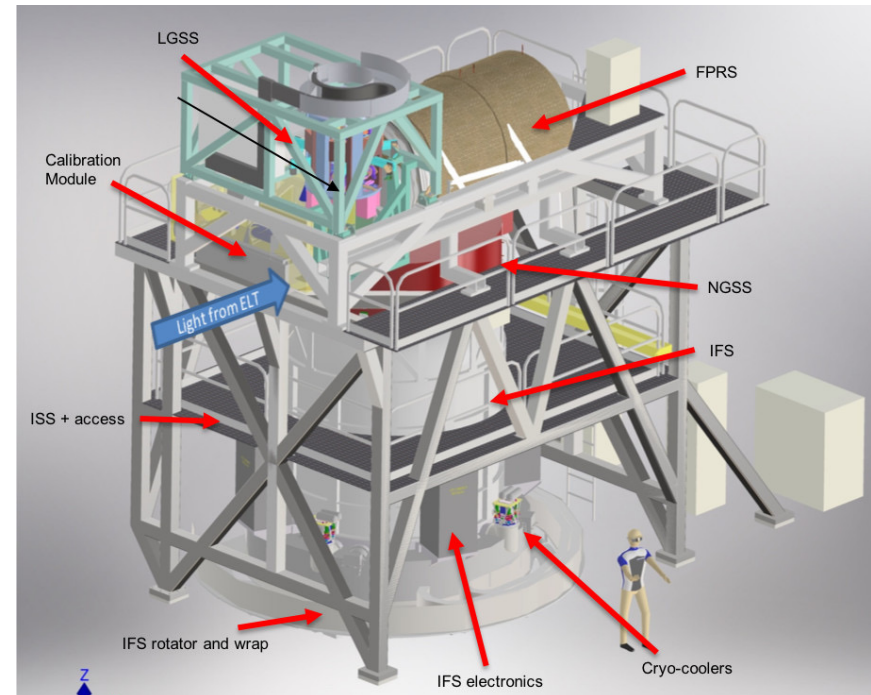
ELT - instruments



Future instruments: ANDES, MOSAIC and PCS

HARMONI

- Spain is a major partner in the HARMONI instrument for ELT
 - Co-I Santiago Arribas (CAB (INTA CSIC))
 - Deputy Co-I Begoña García-Lorenzo (IAC)
- IAC are responsible for the Instrument Control system and for the pre-optics in the HARMONI science instrument
- CAB are responsible for the Calibration module and for a secondary guiding function

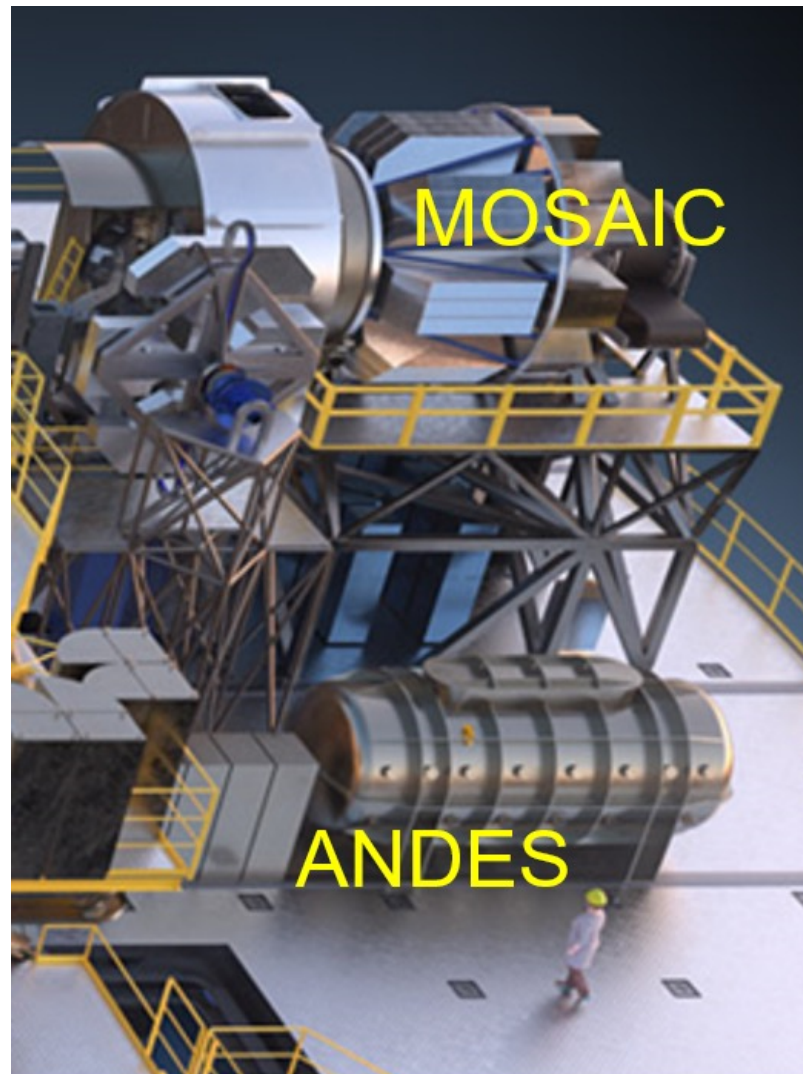


■ ANDES

- Instituto de Astrofísica de Canarias (CI); Instituto de Astrofísica de Andalucía-CSIC; Centro de Astrobiología

■ MOSAIC

- Universidad Complutense de Madrid



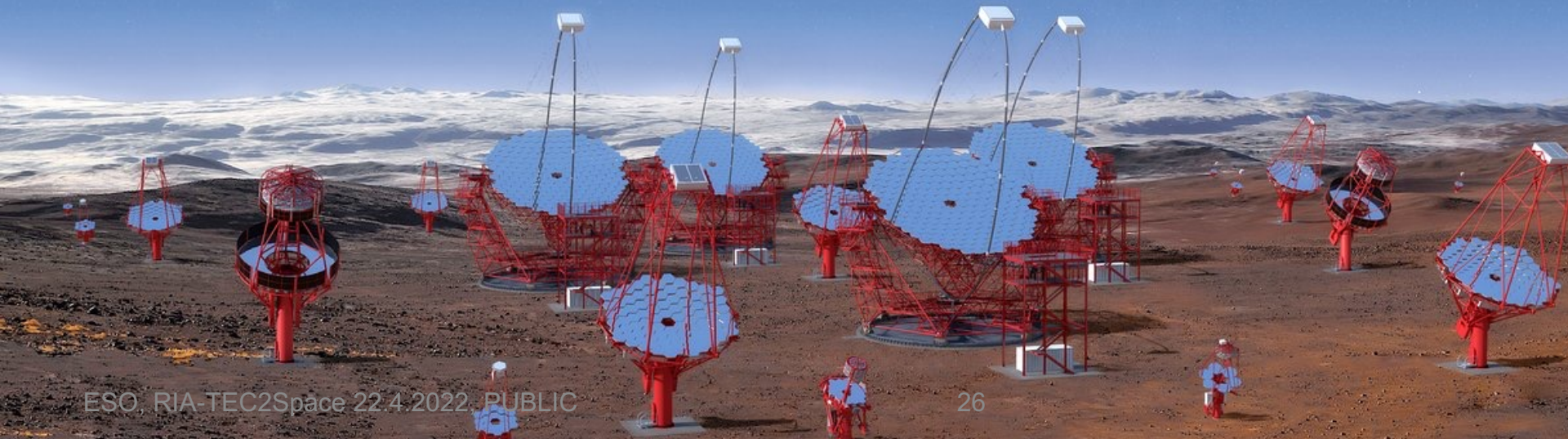


CTA to be built by CTA-ERIC (being constituted)

CTA-Southern array to be hosted and operated by ESO in the Paranal-Armazones area

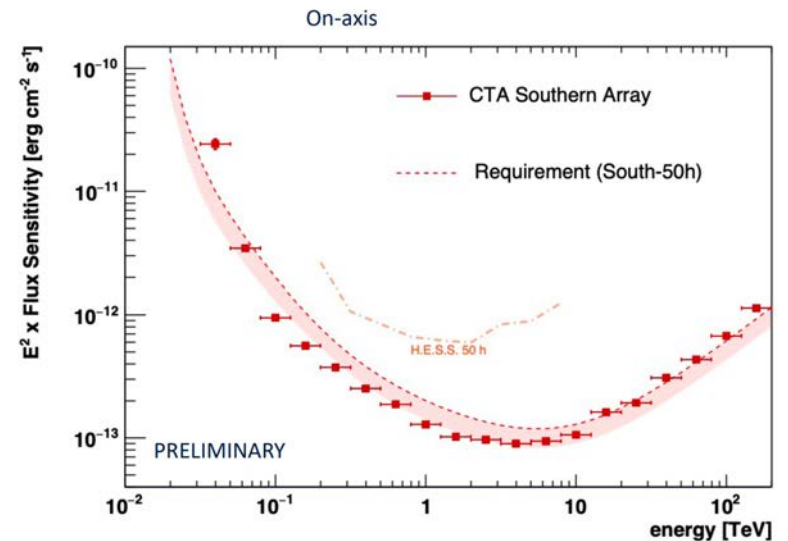
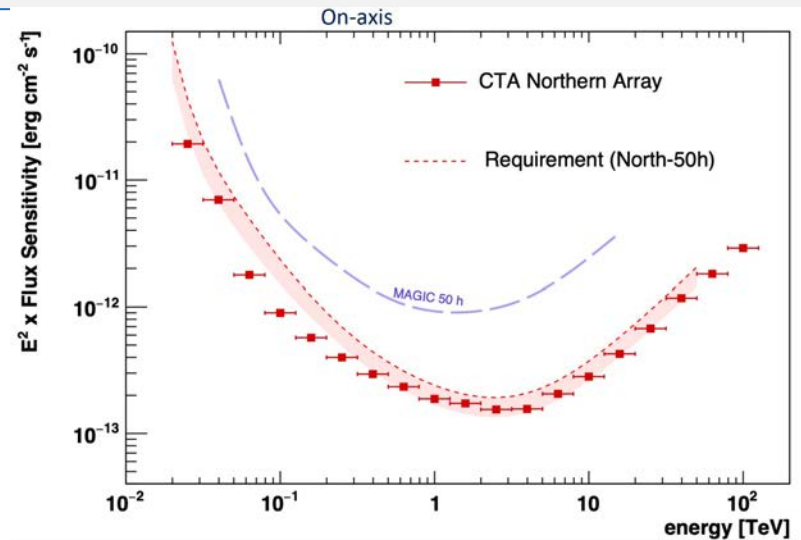
ESO is 8% partner of CTAO (and CTA-ERIC). In return ESO member states will get 10% of the observing time

Infrastructure preparatory construction started in 2021



CTAO – the *Alpha* configuration

- Alpha configuration affordable
 - Cost Book approved unanimously by CTA Council
- CTA-N:
 - 4 LSTs
 - 9 MSTs
- CTA-S:
 - 14 MSTs
 - 37 SSTs
 - Including holes for up to 40 SSTs and 4 LSTs
- Adding 3 to 4 LSTs in the CTA-S is the highest priority



CTA – preparatory construction activities

Access road to CTA-S (ESO Paranal-Armazones)



First stone of the CTA science data management centre (Zeuthen)





ESO Archive Science Portal

518 DATASETS 0 SELECTED J2000 Sgr A* 1'

17.45 40.037 -29 00 28.15 FoV: 14.55°

Data Type

- Switch to Data Subtype
- IMAGE 346
- CATALOG 140
- SPECTRUM 32

Spectral Range

UV
opt
NIR
mm

1 10 100 1k

Undefined for 1 datasets

Filter/Band

- Ks 393
- J 31
- H 18
- Y 12
- Z 12

Show 6 more out of 11

Undefined for 32 datasets

Spectral Resolution

1k-10k
10-100
*-10

10 100 1k

Undefined for 4 datasets

Datasets (518) Sky_selection

Actions	Dist.	Data Type	Spec.Range	Filt.	Spec.Res.	SNR	Sensitiv	Obs.Date	FoV	Sky Res.	Collection	Instrum.	T.Exp.T.	#OE	P.I.	Program Id	Object	Pub.Date
	31.63°	SPECTRUM	994-2479 nm		7900	110.!		2017-06-18 02:4			XSHOOTER	XSHOOTER	1800 s	singl	ORIGLIA, LIVIA	099.D-0258	7680_Galcen	2017-07-21
	31.74°	SPECTRUM	994-2479 nm		7900	13.4		2017-06-17 07:!			XSHOOTER	XSHOOTER	1800 s	singl	ORIGLIA, LIVIA	099.D-0258	7680_Galcen	2017-07-21
	32.7°	SPECTRUM	994-2479 nm		7900	151.!		2017-06-18 01:!			XSHOOTER	XSHOOTER	1800 s	singl	ORIGLIA, LIVIA	099.D-0258	8323_Galcen	2017-07-21
	34.2°	SPECTRUM	994-2479 nm		7900	75.3		2017-06-17 05:!			XSHOOTER	XSHOOTER	1800 s	singl	ORIGLIA, LIVIA	099.D-0258	8116_Galcen	2017-07-21
	35.55°	SPECTRUM	994-2479 nm		7900	18.5		2017-06-18 07:!			XSHOOTER	XSHOOTER	3600 s	singl	ORIGLIA, LIVIA	099.D-0258	9077_Galcen	2017-07-21
	35.98°	SPECTRUM	994-2479 nm		7900	28.2		2017-06-17 00:!			XSHOOTER	XSHOOTER	1800 s	singl	ORIGLIA, LIVIA	099.D-0258	G10812_Galcen	2017-07-21
	36.52°	SPECTRUM	994-2479 nm		7900	197.!		2017-06-18 05:!			XSHOOTER	XSHOOTER	3600 s	singl	ORIGLIA, LIVIA	099.D-0258	8335_Galcen	2017-07-21
	36.59°	SPECTRUM	994-2479 nm		7900	130.!		2017-06-18 04:!			XSHOOTER	XSHOOTER	1800 s	singl	ORIGLIA, LIVIA	099.D-0258	8684_Galcen	2017-07-21
	37.18°	SPECTRUM	994-2479 nm		7900	93.7		2017-06-17 07:!			XSHOOTER	XSHOOTER	3600 s	singl	ORIGLIA, LIVIA	099.D-0258	9349_Galcen	2017-07-21
	51.82°	IMAGE	799-952 μm	870u	5			2007-08-15 02:!	4.44°	18.222°	ATLASGAL	APEXBOL			SCHULLER, FRE	079.C-9501.181	GAL.p015	2016-01-20

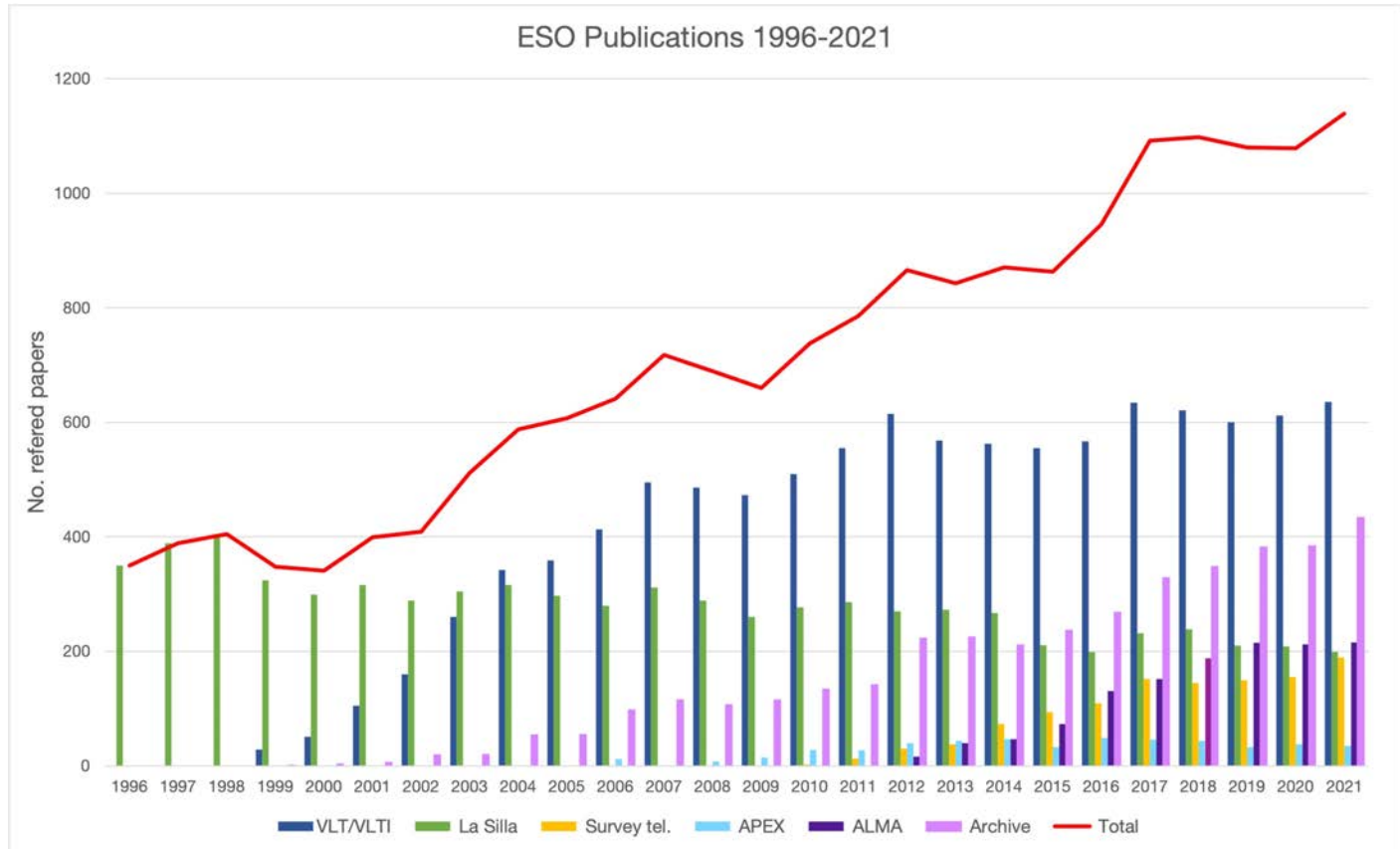


Observing time at ESO's telescopes

- All competitive (both LPO and ALMA)
 - All evaluations are double-anonymous
 - Distributed Peer Review (DPR) in ALMA (Cycle 8+) and La Silla Paranal – LPO (P111+)

- Spanish share of observing time among ESO Member States:
 - VLT (P87-P107, ~15 years)
 - PIs in Spain: 5.5% requested, 3.8% obtained
 - Co-Is in Spain: 6.9% requested, 5.2% obtained
 - ALMA (Cycles 2-8)
 - PIs from Spain: 8.5% proposals requested, 7.6% approved
 - Cycle 7: 7% of observing time obtained
 - Cycle 8: 12.8% of observing time obtained

Science enabled by ESO



- 1,137 refereed papers in 2021 using ESO data
- Around 35% use the ESO Science Archive Facility
- Total refereed papers from 1966 to 2021 in excess of 18,500

Publications based on ESO data from astronomers in Spain

- In 2017-2022 (only refereed papers)
 - 301 papers with 1st author in ES (8% of ESO MS)
 - 1298 papers with a co-author in ES (24% of total)
 - International cooperation works: Higher impact of papers in collaboration with others

Total 2017-2021	Papers	Citations	Average citations
Spain any author	1,289	37,530	29.12
Spain 1st author	301	5,040	16.74
all ESO data papers	5,488	126,890	23.12
Member State 1st author	3,779	86,469	22.88

Science Programmes for the ESO Community

■ ESO Fellowships (ESO/ESA Fellowship coming soon)

- Prestigious postdoc with unique observatory experience, generous travel budget, and scientific training
- In Germany: 3 yr with 25% duties; In Chile: 3 yr with 50% observatory duties + 1 yr full science
- Deadline: Oct 15, every year

■ ESO Studentships

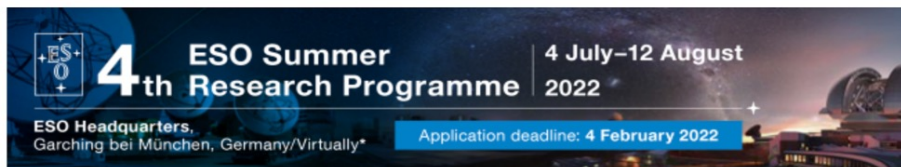
- Up to 2 yr funding for PhD students from institutes in MS and Chile to work at ESO with scientific staff and fellows. In Chile, observatory projects experience
- Deadline: May 31st and November 30th
- IMPRS PhD programme: deadline November 1st

■ ESO Internships

- Single call or two calls/year for Bachelor and Master students
- Deadline: roughly Oct/Nov and Apr/May each year, but flexible

■ ESO Summer Research Programme

- For Bachelor and Master students
- Deadline: early February



Engaging with ESO Community

■ La Silla Observing School



- Biannual call in September
- Lectures on the basics of observing techniques and observations preparation for ESO telescopes
- Hands-on experience in the preparation of a science project, data collection at La Silla Observatory in Chile, reduction, analysis and presentation

■ Hypatia Colloquia

- Promote the work of astronomers at an early stage of their career, giving exposure during the pandemic



Hypatia Colloquium
Early Career Astronomer
series at ESO



Engaging with ESO Community

■ Cosmic Duologues

- Current state of some of the major questions in astronomy via a duologue between two experts in their fields



■ Joint ALMA-ESO colloquium in Chile

- High-impact works using ESO telescopes
- Announced in Chile via ESO library

■ ESO Visitor Programme for Senior and Early-Career Scientists

- Programmes to foster collaboration with scientists in the member states
- Long-term visits by first-rate senior scientists to promote the scientific interaction of ESO with its community
- To support early-career scientists to enrich their professional profile and increase their knowledge of ESO and its facilities through the interaction with ESO staff
- Deadline: no deadlines, any-time submission.

■ ESO conferences and workshops

- In collaboration with scientists and engineers from the community. Sometimes in collaboration with ESA or SKA
- Annual call in September

Total Solar Eclipse (2 Jul 2019) La Silla



Education & Outreach: ESO Supernova in Garching

- A donation from Klaus-Tschira Stiftung, in cooperation with HITS
 - Opened 28 April 2018
- 132 000+ visitors since the opening
 - 1000 planetarium shows
 - 500 guided tours
- 12 000+ students engaged in educational programmes
- Teacher trainings etc
- (pre-COVID) monthly visitor rate ranging from 5000 to 7000
- Exhibit and Planetarium fully open again

supernova.eso.org



Sustainability at ESO

The updated formulation of the **ESO Values** (i.e. assumptions that underpin ESO's activities), underlines **Sustainability**:

...

ESO fosters **Diversity & Inclusion**

ESO believes in the key role of **Sustainability** for its future.

...



■ Social



■ Economic



■ Environmental

ESO and the UN Sustainable Development Goals



ES+O Sustainability and Corporate Social Responsibility

ES+O's benefits to society



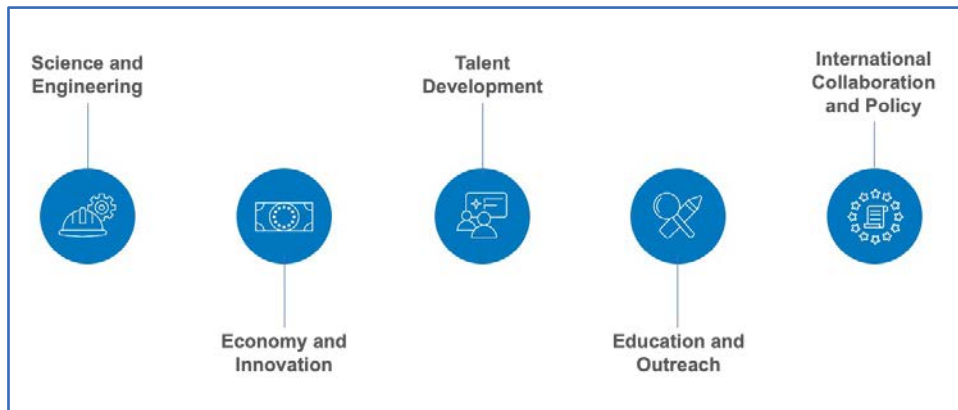
ES+O and UN Women signed [cooperation agreement](#) in 2019. Several objectives, including

- ES+O *Tu Oportunidad* programme to train women in Chile to improve job opportunities (eg mirror coating)

ES+O Gender Equity Plan in development

ES+O A Sustainability & Diversity Officer will be recruited soon

- Vacancy Notice in May 2022



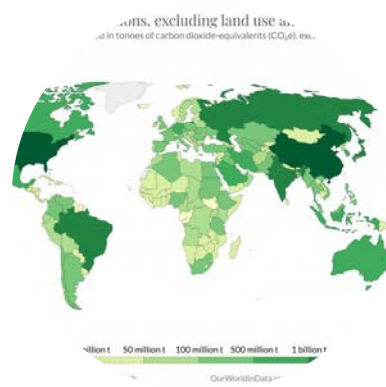
Environmental sustainability



Energy



Water



CO₂

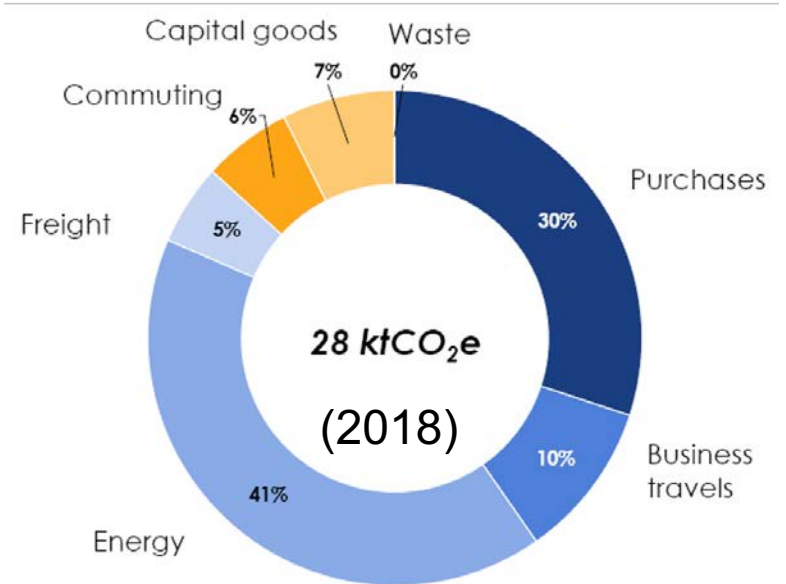


Sewage, biodiversity etc

■ Comprehensive CO₂ savings plan in progress

■ Meanwhile

- 27.7 ktCO₂e (2018)
- 25.7 ktCO₂e (2019)
- 17.4 ktCO₂e (2020)



Summary

- ESO@60 remains at forefront of world-wide astronomy
 - Building largest & most advanced optical/IR telescope, fully funded, and more advanced in construction
 - Multi-project and multi-wavelength: addressing broad science objectives and serving a large community
- Strategy for the 2020s ([Waelkens, Benz & Barcons 2021](#))
 - Complete and put into operation the ELT
 - Keep VLT/I and ALMA competitive
 - Keep ESO ready for developing new projects
 - Retain leadership in ground-based astronomy

- **Keep applying for observing time, including large programmes!!!**
 - Dual anonymous and Distributed Peer Review in deployment
 - Dual time allocation channels (eg ALMA+VLT/I) starting Cycle 10
- Many in science (studentships, fellowships, internships, colloquia, workshops etc)
 - Encourage early career scientists to apply!!!
- Participation in development programmes (for La Silla Paranal and also ALMA).

Thank you!